

## REMARKS

The official action of 28 May 2010 has been carefully considered and reconsideration of the application as amended is respectfully requested.

Claim 13 has been amended to incorporate recitations from claim 20, which require that the rectification zone is a rectification column and that the water-depleted fraction is obtained as a side draw of the rectification column (see, also, Fig. 2).

Claims 33-35 have been canceled whereby to render moot the rejection under 35 USC 112, first paragraph. Claims 28 and 30 have been amended to correct clerical errors.

The claims were rejected under 35 USC 103(a) as allegedly being unpatentable over Kwantes et al, Taylor et al, Hachiya et al and Okamoto et al. Applicants respectfully traverse this rejection.

The claimed invention is based at least in part upon Applicants' discovery that, by cooling and recycling to the reaction zone a water-depleted fraction obtained as a side draw from the rectification column and comprising a specifically controlled water content, it is possible (a) to improve the conversion of acetone; (b) to improve the selectivity of the reaction; and (c) to decrease the temperature within the reaction zone. Specifically, when the water-depleted fraction with controlled water content is cooled and returned as a cycled stream to the reaction zone, such fraction can remove the reaction heat generated within the reaction zone so as to facilitate temperature control therein while improving the conversion of the feedstock to bisphenol A. This is exemplified in the Examples in the specification and described in the Declaration under 37 CFR 1.132 of Zhou Jidong submitted herewith.

The cited references, either alone or in combination, do not show or suggest the claimed method comprising the recycling of a water-depleted fraction obtained as a side draw from a rectification column and comprising a controlled amount of water within the claimed range (i.e., 0 to 2 wt%) and do not recognize the result effective nature of controlling the amount of water within the claimed range. To the contrary, the reference cited by the Examiner for an alleged motivation to combine the references, Okamoto, does not provide a

motivation for recycling to the reaction zone a water-depleted fraction with a reduced amount of water; it provides a motivation not to recycle any water to the reaction zone.

The problem to be solved by Okamoto is to avoid the influence of the water generated in the reaction of acetone and phenol on catalyst activity. Thus, Okamoto teaches that the generated water has to be removed by pervaporation (see Okamoto at col 2, lines 5-23 and col 3, lines 39-54). Following these teachings of Okamoto, the water generated in the reaction must be removed from the reactor as much as possible and **no water** should be returned or recycled to the reactor.

In contrast, in the primary reference, Kwantes et al, a part of a reactor effluent (but not the last reactor effluent) comprising bisphenol, acetone and water is recycled to the first reactor. Kwantes teaches that the recycling, which includes the recycling of water, is required to prevent the acidic ion-exchange resin in the process described therein from suffering a drop in activity after a significant number of run hours. See Kwantes at column 1, lines 8-21 and Examples 1-4. In contrast, Okamoto et al teach that water must be removed from the Okamoto process to prevent a reduction in catalytic activity of the ion-exchange resin described therein *ab initio*. See Okamoto at column 2, lines 18-23 ("For this reason, the reduction in the catalytic activity of the ion-exchange resin due to the presence of water formed starts as soon as the reaction is initiated even if the ion-exchange resin catalyst has been dried prior to use."). Clearly, these are different processes and there would have been no reason or motivation to modify the process of the principal reference by reducing the amount of water in the recycled effluent in the absence of anything to show or suggest how this might affect the activity of the resin in the Kwantes process after, for example, 640 run hours, especially in view of the evidence in the Okamoto Examples which show that the recycled effluent comprising water results in extended resin activity. There *a fortiori* would have been no reason or motivation to control the amount of water in the water-depleted fraction within the claimed range.

Moreover, Okamoto cannot be said to provide, and in fact teaches away from, a motivation for recycling **any** amount of water to the reaction zone. Accordingly, a combination of the cited references relying on Okamoto for motivation would not result in a method wherein even a controlled amount of water obtained as a side draw from a

rectification column is returned to the reaction zone.

Put another way, neither Okamoto nor any of the other cited references recognizes the result effective nature of controlling the amount of water in the claimed water-depleted fraction that is obtained as a side draw from the rectification column and is recycled to the reaction zone. This parameter (the amount of water in the claimed water-depleted fraction) is shown in the Examples of the present specification to be a result-effective variable (compare, e.g., Tables 1 and 2) and is required by the claims to be within a specific range (between 0 and 2 wt%). In the absence of a recognition in the cited references of the result-effective nature of this variable, the references cannot be considered to set forth even a *prima facie* case of obviousness for the invention as claimed. See MPEP 2144.05(II)(B) (“A particular parameter must first be recognized as a result-effective variable, i.e., a variable which achieves a recognized result, before the determination of the optimum or workable ranges of said variable might be characterized as routine experimentation.”).

As with Okamoto, none of the other cited references can provide a reason or motivation for their combination to arrive at the claimed invention. These references are discussed next.

More specifically, Kwantes et al. disclose a process for preparing bisphenol A, wherein part of the effluent from at least one of the reactors is recycled to at least the first reactor. In Example 2 of this reference, two reactors are used, and the effluent of the first reactor is divided into two streams, one stream (50wt%) is recycled to the first reactor and the other stream (50wt%) is fed to the second reactor. Furthermore, as mentioned in this reference, the cycled stream is obtained from at least one of the reactors with exception of the last reactor (see Kwantes specification at column 1 lines 18-21 and lines 45-48), so the cycled stream is not from the last reactor, i.e. not from the final reaction product. It is cycled as such, i.e. without any treatment such as distilling water therefrom.

Furthermore, Taylor et al. relates to recovery of phenols by distillation, more specifically, as disclosed in the Taylor specification at column 1, lines 10-18, a crude phenol containing substantial amounts of water is passed to a dehydration rectification zone to withdraw an overhead fraction, which is substantially an azeotropic mixture of water and

phenol, and a bottom fraction, which is substantially anhydrous crude phenol, which is subsequently passed to a rectifying zone and separated into pure phenol and a bottom fraction. Thus, the disclosure in this reference is a process for purifying crude phenol to obtain pure phenol via rectification zone only.

Similarly, Hachiya et al. relates to a method for producing aromatic polycarbonate, wherein phenol is by-produced and then recovered as a crude phenol product to be utilized as such, i.e. without any purification or the like, for producing bisphenol A, and ultimately for producing aromatic polycarbonate (see Hachiya specification column 1, lines 6-24). In bisphenol A production, the reaction mixture of bisphenol A, phenol and water is separated in light low-boiling point components separating column (see Hachiya specification at column 16, lines 46-67).

Since the Okamoto et al. reference teaches that no water comprising stream should be introduced into the reaction zone and the Kwantes et al. reference discloses explicitly that the recycled stream is not from the last reactor (see Kwantes at specification column 1, lines 18-21 and lines 45-48), there would be no reason or motivation for those skilled in the art to insert a rectification column into the process of Kwantes.

In view of the above, Applicants respectfully submit that the cited references cannot set forth even a *prima facie* case of obviousness for the invention defined by the claims as amended. Moreover, even assuming for the sake of argument that the references could set forth a *prima facie* case of obviousness, Applicants respectfully submit that the evidence in the specification and in the attached Declaration of Zhou Jidong would be sufficient to rebut such *prima facie* case. This is discussed next.

The Examples in the specification show that the claimed process is unexpectedly superior both in the conversion of acetone and the selectivity of reaction as compared to the processes of the Comparative Examples, which are substantially identical with the Examples with the exception that, in the Comparative Examples, the recycled stream is not dewatered prior to recycling.

More specifically, as demonstrated by the Examples, the conversion of acetone is 86%, 87%, 87%, 87.5% and 88%, and the selectivity of reaction is 95.5%, 94%, 96.5%, 95% and 96% (Examples 1, 2, 3, 4 and 5) respectively. In contrast, in the Comparative Examples, the conversion of acetone is of 81 % and 85%, and the selectivity of reaction is 90% and 91% (Comparative Examples 1 and 2) respectively. Please note that all the data of the conversion and the selectivity are with respect to the whole reaction, i.e. with respect the second reactor rather than the first reactor in the Examples and the Comparative Examples.

Thus, a comparison of the Examples and Comparative Examples shows that the conversion of acetone can be increased by 1% at least (86% of Example 1 over 85% of Comparative Example 2) and up to at least 7% at most (88% of Example 5 over 81 % of Comparative Example 1), and the selectivity of reaction can be increased by 3% at least (94% of Example 2 over 91 % of Comparative Example 2) and up to at least 6.5% (96.5% of Example 3 over 90% of Comparative Example 1).

From this data, those skilled in the art would appreciate that the claimed invention does make significant improvements and bring about unexpected technical results, because in chemical engineering industry an improvement of even 1% in terms of conversion or selectivity is significant.

The Examiner asserts that there is not a significant improvement between the acetone conversion level and selectivity in Example 1 and Comparative Example 1 (see Office Action at page item 18). However, in Example 1, the acetone conversion is 86% and the selectivity is 95.5% (see specification at page 16 below Table 1 lines 2-3). In Comparative Example 1, the acetone conversion is 81% and the selectivity is 90%. (see specification at page 17 below Table 2 lines 2-3). Thus, a comparison between Example 1 and Comparative Example 1 shows the conversion of acetone and the selectivity of reaction can be increased by 5% and 5.5% respectively. The Examiner has respectfully provided no rationale for the assertion that this improvement is insignificant.

Furthermore, in Kwantes, Example 1 is without recycled stream but Examples

2-4 are with recycled streams of the first reactor effluent at different percentages respectively. Thus, Kwantes Example 1 is comparative. Since the purpose of this reference is to maintain the resin activity (see col. 1 lines 17-21), the stability during the operation is primarily investigated in the Examples. Comparing the continuously analyzed conversions in Examples 1-4, it can be seen that the operations in Examples 2-4 are more stable than in Example 1, because the profiles of the conversions in Examples 2-4 are more flat than those in Example 1. In other words, the purpose of recycling effluent in Kwantes is to maintain stable operation notwithstanding that the conversions are not very high.

In the claimed invention, the operation is stable too, but the conversions of acetone are greatly improved. More specifically, the lowest conversion of acetone of 86% of Example 1 in the present application is much greater than the highest ones of 54%, 58% and 52% in Examples 2-4 in the closest prior art reference, Kwantes. Thus, the evidence of record is probative of nonobviousness for this reason as well. See, also, MPEP 716.02(e)(1) ("Applicants may compare the claimed invention with prior art that is more closely related to the invention than the prior art relied upon by the examiner.").

In view of the above, Applicants respectfully submit that all rejections and objections of record have been overcome and that the application is now in allowable form. An early notice of allowance is earnestly solicited and is believed to be fully warranted.

Please charge Account No.12-0425 for any fees which may be due by this paper.

Respectfully submitted,

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***PATENT***

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

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**DECLARATION UNDER 37 C.F.R. 1.132**

## INVENTOR'S REMARKS

I, 周继东(Zhou Jidong), one of inventors of this invention, now provide following remarks about this invention over the four cited references cited in the final OA:

I majored in chemical engineering and graduated from Beijing University of Chemical Technology in 1984, and received the Master degree of Chemical Engineering from Beijing Chemical Engineering University in summer of 1995.

I worked in Research Institute of Beijing Yansan Petrochemical from 1984 to 2005, engaged in the design and development of chemical engineering. From 2005 to 2006, I worked in engineering department of Sinopec Co. as professorate senior engineer. From 2006 to now, I work in Beijing Research Institute of Chemical Industry, as deputy director of Production & Technology Department, and undertake the design and development of chemical engineering.

I have published dozens of papers, applied 14 items of Chinese patents and gained twice Technology Advancement Award of Sinopec Co. I have profound theoretical knowledge and well experience in design of chemical engineering.

### 1. Regarding Okamoto et al. reference (US5087767):

In the final OA, this reference is deemed to teach that the water generated during the preparation of bisphenol A must be reduced.

However, according to the invention of this application, the stream comprising bisphenol A obtained after reaction is processed outside of the reaction zone, then the fraction returned to the reaction zone would comprise less water and bisphenol A than the reaction stream, thus, less reaction products will be brought back so that to facilitate the continuation of the reaction of acetone and phenol. Thus, according to the invention of this application, the catalytic activity of the ion exchange resin is not the only one being concerned.



According to Okamoto et al. reference, the pervaporation is conducted within the reactor in following two manners:

- 1). Under reduced pressure and usual temperature, thus, a vacuum condition would result in complicated operation; furthermore, the membrane used therein is with limited capacity for separating water; then this method is merely suitable for a batchwise stirred reactor rather than a continuous fixed bed reactor.
- 2). under usual pressure and high temperature, thus, the water vapor could pass the membrane; however, the high temperature may deactivate the catalyst quickly.

According to the invention of this application, the reaction stream is distilled outside of the reaction zone to obtain a water depleted fraction to return to the reaction zone. Viewing the technical effects, since the water depleted fraction has a water content of not greater than 2wt%, the reaction selectivity and acetone conversion were improved significantly.

Although both the invention of this application and Okamoto et al. reference conduct water reducing operation, their purposes and processes are different from each other. At least, removing water with membrane and distilling out water with rectification column is different significantly.

2. Regarding Kwantes et al. reference (US4308404,JP54-019951):

It has to be noted that the fraction to be recycled to the reaction zone in this invention is different from that in Kwantes et al. reference. According to the invention of this application, the final reaction effluent is further processed to obtain the water depleted fraction to return to the reaction zone, more specifically, the reaction stream obtained after reaction is transferred into a rectification column, then a water depleted fraction primarily comprising phenol, bisphenol A and acetone is withdrawn from the rectification as a side draw in liquid, cooled via heat exchanger and returned to the reaction zone. After being cooled, the recycled water depleted fraction can decrease the reaction temperature; thus, prevent the deactivation of the catalyst due to high temperature.

Comparisons between the invention of this application and the Kwantes et al. reference are listed in following table:

	According to this invention	According to Kwantes et al. reference
Source of recycled fraction	Distilling final reaction effluent in rectification column and withdrawing as a side draw in liquid	Recycling intermediate reactor effluent as such
composition of the recycled fraction	water and bisphenol A being reduced over the reaction effluent	Same as the reaction effluent
Technical effects	Facilitating the continuation of the reaction due to less water and bisphenol A The cooled water depleted fraction decreases the reaction temperature, thus, prevents the deactivation of the catalyst due to high temperature The water depleted fraction in liquid can save the energy for cooling the same The acetone conversion can be more than 80%.	In Examples 1-4, the acetone conversion of first reactor is about 40%, and the acetone conversion of second reactor is about 60%.

3. Regarding TayLor et al. reference (US2486342):

The invention of this application is aimed at obtaining a side draw in liquid by distilling the reaction stream rather than recovering phenol and the recycled fraction is not obtained via evaporation.

TayLor et al. reference discloses a process for recovering phenol by distillation, wherein the top fraction primarily is the azeotrope of water and phenol, and the bottom fraction primarily is anhydrous crude phenol. Thus, TayLor et al. reference teaches neither recycling a fraction to the reaction zone nor withdrawing a fraction as a side draw.

4. Regarding Hachiya et al. reference (US6277945):

In Hachiya et al. reference, the mixture of bisphenol A, phenol and water is separated only, no dewatering is conducted. However, according to the invention of this application, the side draw has reduced water content.